

5 METHOD OF MANUFACTURING A FACE PLATE FOR A GOLF CLUB HEAD

BACKGROUND OF THE INVENTION

 This invention relates generally to golf clubs and, in particular, to so-called metal wood
10 drivers.

 Recent developments in golf club design have included improvements in drivers, which
are clubs used primarily to strike a golf ball resting on a golf tee. These improvements have
resulted in drivers with club heads consisting of a hollow shell usually made of metal, such as
steel, aluminum, or titanium. These hollow shells have relatively thin walls including a thin
15 front wall that is used to impact the golf ball. In order to prevent the front wall of these hollow
shells from permanently deforming or cracking upon ball impact, it has become necessary to
reinforce the front wall. One example of a golf club head consisting of a hollow metal shell with
a reinforced front wall is disclosed in U.S. Patent No. 4,511,145 to Schmidt. The club head
disclosed in the Schmidt patent has an arched ridge extending between the heel and toe ends of
20 the front wall. The arched ridge design of the Schmidt provides adequate reinforcement for
drivers of moderate head volume, however, in an effort to obtain better and better performance
from these hollow metal wood drivers, golf club manufacturers have increased the head volume
from the moderate volume of 200 cc's to over 400 cc's during the past decade. As head size
increases, less and less material is available to reinforce the front wall of the club face within
25 acceptable weight limitations (i.e., around 200 grams mass). Consequently, more exotic
materials such as forged or cold rolled titanium faces welded to a cast titanium body have been

utilized in these super-oversized drivers. The rear surfaces of the front walls of these super-oversized drivers must be carefully contoured to provide adequate structural strength with a minimum amount of material.

The most critical region to reinforce, is, of course, the ideal ball impact point of the front wall. Because most golfer's swings vary somewhat from impact to impact, the reinforced region of the front wall must be distributed around the ideal impact point. However, since variations in a golfer's swing tend to be more in the heel and toe direction, rather than up or down, the distribution of hits tends to be within a horizontal, elliptical region rather than a circular region centered around the center of the club face. Accordingly, an elliptical, rather than a purely circular reinforcement is preferable. One example of a golf club head having a face with a contoured rear surface is U.S. Patent No. 6,354,962 to Galloway, et al. The club head disclosed in Galloway has a face plate reinforced with elliptical regions that are formed as part of the forging process of the face plate. For clubs in which the club face is machined from a wrought alloy sheet or other sheet material, forming an elliptical reinforced region presents special problems. The face cannot be machined properly on a lathe because the lathe will produce only a circular reinforced region. One manufacturer is known to use an end mill that makes multiple elliptical passes to machine the reinforced region of the golf club face. This operation is, however, time consuming and unnecessarily costly.

SUMMARY OF THE INVENTION

According to the present invention, a golf club head is manufactured by removing a portion of the rear surface of a face plate to form a central thickened region surrounded by a transition region that tapers to a thinner peripheral region. According to the illustrative

embodiment, the face plate is a rolled sheet titanium alloy between 0.130 and 0.180 inches thick, a portion of the transition region of which is machined away to leave the central thickened region and to form the transition region and the thinner peripheral region. Rather than forming the rear surface contour of the face plate by making multiple passes with an end mill, however, 5 the central portion, the transition region and the peripheral region are formed in a single elliptical pass with a special cutting tool. The cutting tool, or "form cutter" has a conical lateral cutting surface, which forms the transition region and the peripheral region in a single operation. Use of this form cutter to machine the transition region and peripheral region in a single operation yields greater uniformity in the rear surface contour of the face plate and saves substantial time 10 and money over prior art multiple pass machining operations.

BRIEF DESCRIPTION OF THE DRAWING

The present invention will be better understood from a reading of the following detailed description, taken in conjunction with the accompanying drawing figures in which 15 like references designate like elements, and in which:

FIG. 1 is a partially cut-away rear perspective view of a golf club incorporating features of the present invention;

FIG. 2 is a rear cross-sectional view of the golf club of FIG. 1;

FIG. 3 is a cross-sectional view of the golf club of FIG. 2 taken along line 3-3;

20 FIG. 4 is a cross-sectional view of the golf club of FIG. 2 taken along line 4-4;

FIG. 5 is a side view of a machining step in the method of forming golf club head in FIG. 2;

FIG. 6 is a side view of an alternative cutting tool used in the machining step of FIG 5;
and

FIG. 7 is a side view of another alternative cutting tool used in the machining step of
FIG 5.

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DETAILED DESCRIPTION

The drawing figures are intended to illustrate the general manner of construction and are not necessarily to scale. In the description and the in the drawing figures, specific illustrative examples are shown and herein described in detail. It should be understood,
10 however, that the drawing figures and detailed description are not intended to limit the invention to the particular form disclosed but are merely illustrative and intended to teach one of ordinary skill how to make and/or use the invention claimed herein and for setting forth the best mode for carrying out the invention.

Referring to FIG. 1, a golf club 10 includes a head 12, a hosel 14 and a shaft 16. Head
15 12 includes a hollow body 18 made of a metal material such as titanium. Hollow body 18 is formed as a shell 20, which may be assembled from a series of forged pieces but, in the illustrative embodiment, comprises a titanium investment casting. A face plate 22 is attached by conventional means such as plasma or electron beam welding to a corresponding opening 23 (Fig. 2) in shell 20 to form hollow body 18. Face plate 22 may be a conventional forged blank
20 but, in the illustrative embodiment, comprises a rolled sheet titanium blank that is machined prior to welding to shell 20 as described more fully hereinafter.

As noted hereinbefore, because a golfer's swing tends to vary more in the heel-toe direction than it does up or down, the inventor of the present invention determined that the most

efficient reinforcement would be an elliptical thickened region oriented so that the major axis of the reinforced region was substantially horizontal when the club is held in its normal position for addressing the ball. Accordingly, face plate 22 includes a central thickened region 24 that is substantially elliptical in shape with its major axis 26 oriented horizontal when the club is held in its normal address position. In the illustrative embodiment, central thickened region 24 is between 0.130 and 0.180 inches in thickness. Central thickened region 24 is surrounded by a transition region 28 that tapers from the central thickened region 24 to a peripheral region 30, which in the illustrative embodiment is 0.080 to 0.120 inches thick. Transition region 28 is also elliptical, however, for reasons that are explained more fully hereinafter, the major axis and minor axis of transition region 28 are a fixed amount larger than the respective major and minor axis of central thickened region 24. Accordingly, the aspect ratio of transition region 28 is lower than the aspect ratio of central thickened region 24 (in other words, transition region 28 is a "fatter" ellipse than central thickened region 24).

With reference to FIGs. 2-5, prior to assembly of face plate 22 to shell 20, the rear contours of face plate 20 are formed by a machining operation shown schematically in FIG. 5. The process begins with a blank face plate 32, which in the illustrative embodiment comprises a blank stamped from a rolled sheet of titanium alloy. The blank face plate 32 has a thickness equal to the final thickness of the central thickened region 24 of the finished face plate 22, which as noted hereinbefore is from 0.130 to 0.180 inches in thickness. The rear surface of blank face plate 32 is machined by using a cutting tool 34 to remove a portion thereof. The tip of cutting tool 34 has a lateral cutting surface 36 and a lower cutting surface 38. Lower cutting surface 38 is perpendicular to the axis 40 of cutting tool 34. Lateral cutting surface 36 is angled upward with respect to lower cutting surface 38 by an angle 42 of from about 5 to 20 degrees, but

preferably about 13 degrees such that lateral cutting surface 36 defines a generally inverted conical frustum surface of revolution 44 as cutting tool 34 is rotated about its axis 40. Lateral cutting surface 36 may have straight edges as shown in FIG 5, or may have edges 36b that are concave downward as in the cutting tool 34b shown in FIG. 6, or may have edges 36c that are convex downward as in the cutting tool 34c shown in FIG. 7. yielding a conical frustum surface of revolution (and corresponding transition regions) having correspondingly curved sides.

As can be seen from FIG. 5, as the lower cutting surface 38 and lateral cutting surface 36 are brought into contact with rear surface 46 of blank face plate 32, lower cutting surface 38 and lateral cutting surface 36 cooperate to cut a tapered transition region 28 and a flat perimeter region 30 simultaneously in a single pass, thus obviating the need to make multiple passes with an end mill as in the prior art. With particular reference to FIGs. 2-4, the major axis 26 of central thickened region 24 is from 0.65 to 1.05 inches in length. The minor axis 48 of central thickened region 24 is 0.25 to 0.45 inches in length. Accordingly, the aspect ratio of central thickened region 24 is between 1.4 and 4.2. In the illustrative embodiment, major axis 26 is approximately 0.85 inches and minor axis 48 is approximately 0.35 inches yielding an aspect ratio of approximately 2.4.

Major axis 50 and minor axis 52 of transition region 28 are a fixed amount " δ " greater than the respective major and minor axes of central thickened region 24. In the illustrative example, the major axis 50 and minor axis 52 are approximately 0.86 inches greater than the respective major and minor axes of central thickened region 24. Thus, major axis 50 in the illustrative embodiment is approximately 1.71 inches in length and minor axis 52 of transition region 28 is approximately 1.21 inches in length. Thus, the aspect ratio of transition region 28 is approximately 1.4 as opposed to the 2.4 aspect ratio of central thickened region 24. The high

aspect ratio central raised portion surrounded by the lower aspect ratio transition region provides optimum distribution of material for improved performance and reliability.

Although certain illustrative embodiments and methods have been disclosed herein, it will be apparent from the foregoing disclosure to those skilled in the art that variations and
5 modifications of such embodiments and methods may be made without departing from the spirit and scope of the invention. Accordingly, it is intended that the invention should be limited only to extent required by the appended claims and the rules and principals of applicable law.